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TRANSACTIONS
of
THE NEW YORK ACADEMY OF SCIENCES

Ser. II, Vol. 4 June, 1942 No. 8

SECTION OF GEOLOGY*

May 4, 1942

Doctor Girard Wheeler, Chief of Subsurface Exploration Section, N. Y. C. Department of Public Works: *Recent Subsurface Explorations in New York City.* (This lecture was illustrated by lantern slides.)

The Department of Public Works was organized under the new City Charter in 1938. In 1939, the Subsurface Exploration Section was established in order to provide soil, rock and groundwater data for designs made by the Bureaus of Sewage Disposal, Architecture and Bridges.

Because so large a part of New York City is covered with buildings or pavements, it is usually necessary to obtain subsurface information by means of borings. In soil or soft rock, spoon ("dry") samples are obtained. In hard rock, cores are obtained by diamond drilling. Since the borings are made in order to obtain data which are not clearly known in advance, it is sometimes difficult to arrange an equable boring contract. For this reason

*The Section of Psychology met May eighteenth. No abstract was received from Doctor David Wechsler, who gave an address entitled, "Psychological Aspects of Projective Techniques, with special reference to their Military Application."

TRANSACTIONS of The New York Academy of Sciences, Series II, Volume 4. No. 8, June, 1942.

This publication is distributed to Members and is published monthly from November to June, inclusive, at 109 West Chestnut Street, Lancaster, Pa., by The New York Academy of Sciences, Seventy-ninth Street and Central Park West, New York City.

Associate Editor: Eunice Thomas Miner, Executive Secretary.

Entered as second-class matter December 2, 1938, at the post office at Lancaster, Pa., under the act of August 24, 1912.

the policy of the Department of Public Works has been to do this work with its own equipment and forces, which continuously operate five drilling rigs. During the first 26 months of operation, 710 borings were made on 65 project sites. A total of 40,578 feet of soil and rock was drilled at a cost of $80,440, or $1.99 per foot. This cost of exploration represents 2/10ths of 1% of the cost of the engineering projects involved.

This extensive sampling of the subsurface of New York City has provided an unusual opportunity for collecting geological material and correlating it with current engineering needs and practice. As geologist, the writer has found many duties which it seems worth while to describe briefly. In general, the chief function of the geologist has been to classify, to interpret and to interpolate. For example, a well known source of trouble in construction is the occurrence of boulders. Engineers are not always able to appreciate the significance of several large boulders encountered by borings in a compact mixture of sand, gravel and clay. The geologist, on the other hand, may well interpret such an occurrence as till, and if this be the case, he may predict the probable existence of many boulders.

In a closely built-up city such as New York, the exact elevation of water is of considerable importance on almost any engineering project. Hence, another function of the geologist has been to interpret ground water records and predict on the basis of such records.

Since all engineering projects rest upon soil or rock, whose "presumptive bearing capacity" is defined in the New York City Building Code, it is incumbent upon the geologist to assist the designer in predicting the behavior of soil or rock under given methods of excavation, construction and loading. It quickly became apparent, as our subsurface work progressed, that precise quantitative estimates were necessary. This, in turn, required the installation of a soil mechanics laboratory. As a result, the designer is now provided with preliminary geological estimates of soil compressibility, shear strength, pre-consolidation, etc., and, as boring samples are obtained, he is given valuable laboratory test results.

This combination of qualitative geological analysis and quantitative laboratory analysis is a most satisfactory one. Once a given soil, for example the Gardiners clay, is shown by test to have been pre-consolidated by a glacial ice load as much as 3 or 4 tons per square foot greater than the present soil load, then a prompt geological recognition of "Gardiners clay" becomes of immediate value to designers.

Another obvious design need has been a correlation, in engineering terms, between soils as described in geological publications and the behavior of these soils under stress. To satisfy this need, an engineering soil-province map of New York City has been made with the following tentative provinces:-

Provinces	*Sub-provinces*
1. End Moraine Belt	
2. Outwash Plain	
3. Ice Recession Complex	3a. Lower Manhattan
4. Shore Zone	4a. Harlem River
	4b. Flushing Bay
	4c. Newton Creek
	4d. Gowanus Canal

Each province has been described in terms of soil engineering. By way of illustration, the description of the End Moraine Belt may be quoted:-

"Surface Soil:	Mixed material, including boulders, gravel, sand, silt, clay. Commonly unsorted "till" or boulder clay with wide dispersion of sizes. In places well bedded and sorted, sand or gravel.
"Bearing Capacity:	Building Code, 2–6 tons per sq. ft. Common design, 3–4 tons per sq. ft. Ultimate capacity, 4–10 tons per sq. ft.
"Subsoils:	Chiefly sand and gravel.
"Remarks:	This soil province contains some of the best bearing material in New York City. A

good guide is often found in existing structures on adjacent property, but there are occasional irregularly distributed ponds and marsh deposits, usually of shallow depth. Groundwater table commonly deep, but owing to the presence of impervious layers or lenses there are occasional perched water tables near the surface. A few borings may be sufficient for exploration, carried to relatively shallow depths, chiefly to ascertain fill and groundwater conditions. Piles seldom required. Bedrock out of reach (except in parts of Staten Island)."

Still another function of the geologist has been to help in determining the proper relations between subsurface exploration data and the specifications of the subsequent foundation contract. This determination is of importance in order that the contractor may understand clearly just how much is known or not known regarding subsurface conditions and just how he is to be paid for footing excavations, piles or caissons, etc.

In consequence of the fact that it is difficult to formulate a perfect subsurface contract, and because legal controversies often arise, it is not infrequently the case that the geologist is called upon to give expert testimony in court. Such testimony is greatly strengthened, when the City is defendant, by offering in evidence actual boring samples obtained by city employees.

Finally, geological information has been utilized by the City in purchasing or selling land, for the value of land often depends in part upon the quality of soil or rock present.

The foregoing paragraphs have treated in general terms some methods of application of geology to engineering. Naturally, these explorations have shed some light on a number of purely geologic problems.

An interesting example is the origin of the extensive zone of deeply weathered gneiss in the Newtown Creek area. The bed-

rock in this area is thoroughly decomposed to depths of as much as 80 feet. The rather soft brown and white residual clay has been previously observed by Kerr (1), who subscribes to the Humphreys and Julien (2) explanation of leaching by corrosive action of pre-glacial peat bogs. It would seem reasonable to add the hypothesis that this clay represents the uneroded product of pre-Cretaceous weathering. This explanation is supported by the presence, in close proximity to the decomposed gneiss, of the lowest Cretaceous beds. Such an hypothesis would not necessarily vitiate the "bog weathering" concept, but would change very greatly the geological age to which the weathering is ascribed.

Another problem is to account for the breach in the terminal moraine at the Narrows between Brooklyn and Staten Island. As far as the writer is aware, there is no known evidence which would rule out the possibility of end-moraine deposits actually being present beneath the Narrows. On the other hand, borings taken in land and water off Owl's Head, Brooklyn, reveal a pebble lithology which suggests the former presence of a Hudson Valley ice tongue at this point. If this should prove to have been the case, it might well explain the breach in the moraine at the Narrows, since a late glacial valley tongue could easily remove former end-moraine debris.

Still another problem is to explain and correlate the sediments deposited in the New York Shore Zone areas after the last melting of glacial ice. At a number of locations beneath the soft surficial organic silts and clays of the waterways there have been found deposits of loose sand, 10–30 feet thick, which, in turn, are underlain by varve clays or varve-like clays. The clays, the loose sand and the soft silt all appear to be post-glacial in origin; but the genesis of the sedimentary types is not clear, nor is the precise dating. As yet, no fossils have been found in either clays or sand. Their absence might be accounted for by deposition in ponded areas shut off from the sea.

It is interesting that at the many sites thus far bored to rock, no trace has been recognized of two distinct till deposits. This apparent anomaly is cited, not so much to suggest that ice ad-

vanced over the New York City area only once during the Pleistocene, but to emphasize two other possible explanations: first, that a second ice advance may have obliterated earlier till deposits; second, that since till is upon occasions difficult to recognize in boring work, it may have been penetrated without recognition.

By far the most interesting question is the relationships of the varied soils which are commonly called "Gardiners Clay", or "Sankaty" of Veatch (3). For example, on the west side of Flushing Bay, at the site of the World's Fair, the succession of strata is, in descending order: 50–80 feet of very soft organic silt and clay, 10–30 feet of very compact yellowish sand and rounded quartz pebble gravel with broken shells, 20–60 feet of soft to moderately stiff varved clay, several feet of till with trap boulders, and bedrock. The varved clay occupies a position which would be appropriate for Gardiners clay, except that it is not overlain by a till. That the varved clay actually represents lacustrine or very quiet water deposits is hardly to be doubted. In its upper portion, approaching the shell-bearing gravel, it contains irregular zones of red fine sand, such as is characteristic of many Pleistocene sediments derived from the Newark red beds of New Jersey. One may visualize a pond filling and shoaling, but it is not so easy to explain the compact shell-bearing gravel at elevations of −60 to −80.

Crossing to the east side of Flushing Bay, the uppermost strata are 60–80 feet of soft organic silt, underlain by 5–10 feet of compact sand and variegated clay, and a thick deposit of very stiff thinly laminated carbonaceous clay containing carbonized layers and pyritized plant stems. One can hardly doubt that the sand and variegated clay are the equivalent of the shell-bearing gravel occurring on the west side of the bay, or that the carbonaceous pyrite-bearing clay is the equivalent of the varved clays on the west. The surmise comes readily to mind that the plant-bearing clay may represent bog deposition in an area bordering on lacustrine deposition of varved clays, and that there are wave-action products in the shell-bearing gravel and weathering products

in the variegated clay, both of which occur at elevations −60 to −80. A comprehensive explanation of these deposits, however, must await further study and additional borings.

On the north side of Long Island Sound, a short distance from Flushing Bay, typical shell-bearing gray Gardiners clay is found at elevation −20 beneath bouldery till.

In the Newtown Creek area, at elevations appropriate to the Gardiners, sandy laminated clay with pyrite and carbonized wood occurs immediately beneath bouldery till.

In the Brooklyn Navy Yard, beneath till is shell-bearing Gardiners clay.

If all of these clays are Gardiners, then one is forced to the concept previously advanced by Veatch (4) that "These sediments therefore vary from truly swampy deposits, on the one hand, to relatively fine sands and clays, which show no trace of swamp origin, and which contain shallow water mollusks, on the other..." But the clays of Flushing Bay are somewhat unusual in that they are varved, and moreover do not seem to have been over-ridden by ice, hence must find special explanation. Perhaps there were small "driftless" areas near the Long Island terminal moraines, or perhaps the Pleistocene Gardiners is being confused with either post-Gardiners clay or residual pre-Pleistocene clays of somewhat similar composition. Just as in soils engineering one quickly adopts the principle "make one more boring than is necessary,—otherwise, there will be one boring too few," so in New York City geology one must always await with patience the results of "one more boring."

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SECTION OF BIOLOGY

MAY 11, 1942

RAYMUND L. ZWEMER, Department of Anatomy, College of Physicians and Surgeons, Columbia University, New York City and the Instituto de Fisiologia, Universidad de Buenoi Aires, Buenos Aires, Argentina: *Uniformity of Responses to Potassium of Various Argentine Animal Species.* (This lecture was illustrated by lantern slides.)

The paper is a continuation of work presented before this section of the New York Academy of Sciences in December, 1936.

In attempting to determine what effect a prolonged increase in body fluid potassium might have on an individual, Dr. Truszkowski and I (1936,1938) were forced to abandon the techniques used up to 1935 and devise two new ones.

Aside from the study of ion changes in the fluids bathing isolated organs and tissues, the mode of potassium administration to the intact animal at that time was either by mouth or by vein. The absorption of the orally administered dose proved to be too slow to produce a measurable increase, while the intravenous injection of KCl solutions produced death at once, or a rapid return to normal levels. Continous intravenous methods involve many complicating factors difficult to control accurately. We, therefore, adopted intraperitoneal injection of a hypertonic solution of KCl which permitted absorption slow enough to be studied yet rapid enough to produce easily detectable changes in plasma K concentration.

It was also necessary to do micro determinations in large numbers in order to get curves and not just before and after samples. We thus obtained plasma K curves for various doses of K salts in solutions.

Potassium changes influencing cell physiology and pathology have been carefully studied during 1941 in Professor B. A. Houssay's laboratory with the kind collaboration of Drs. F. B. Arrighi, V. H. Cicardo and J. B. Odoriz.

A criticism that needed to be met was the possibility that clinical symptoms accompanying the K rise might be due to the anion (Cl), the hypertonicity of the solution administered or the amount of the solution given. It was found that the same total amount of K per kilogram body weight was lethal, whether given as the 2%, or any per cent up to 10% solution. The chlorides of Na or Ca when given in similar concentration had no such effect. Extremely large amounts of NaCl solution were given with beneficial rather than deleterious effect on the K symptoms.

In all the species studied, the lethal dose did not differ by more than a factor of 2. The individual variations, in response to a given non-lethal dose, were as great within a species as were variations from one species to another. This confirmed results previously obtained in the United States and Poland. This lethal dose is about 1cc. of 10% KCl per 100 grams body weight of animal. We can express this as 52 mg. K per 100 grams. This should be compared with a normal muscle content of about 400 mg. per 100 grams, given by Dr. H. Burr Steinbach, as present in many different animal species.

K differs from most other toxins which have wide species variations. Notable contrasts exist between cold-blooded and warm-blooded animals, and for mammals between the rat and the guinea pig.

The 50% lethal dose is a better one to test the protective effect of various types of therapy and was used by Truszkowski and Duszinska in K adrenal studies.

The clinical symptoms common to all species were: (1), the gradual appearance of skeletal muscular asthenia; (2), circulatory disturbances grossly noticeable as edema and slowing of the heart; (3), disturbance of autonomic system; and (4), effects on the central nervous system.

Naturally, the anatomy and physiology of each species brought about minor variations in the general picture. This is seen in the description which follows for a single lethal dose (Multiple doses will not be considered as they involve too many complications).

Mammals showed an initial marked stimulation of the autonomic nervous system which might be due to local reflex action of the K on visceral sensory neurons.

Partial paralysis of hind legs within 15 minutes of injection is followed by progressive weakness of the abdominal musculature and of the fore-limbs until, eventually, the animal is unable to stand or right itself, if turned over. The edema is manifested by puffiness of the face especially around the eyes. This is particularly noticeable in the guinea pig, which, also, shows the respiratory difficulties typical of anaphylaxis. The anesthetic effect on the central nervous system can be detected grossly by the disappearance of reflex responses to peripheral touch. This wili be dealt with more fully later.

In birds, the ability to fly disappeared before the ability to stand. This reverses the limb order of mammals and is interesting in connection with functional evolution.

Of the reptiles, snakes were used because large quantities were easily available.

Ophis merremi (hooded snake). The name comes from the habit of flattening the neck by elongated ribs—after K, the whole body was flat but would round up on stimulation.

Crotalus terrificus (Cascabel) rattlesnake. To watch one strike in slow motion after K is an experience.

Bothrops alternatus (Pit Viper) Urutu. May reach five feet, but as with most snakes, weigh surprisingly little for their length.

Bothrops neuwiedii (Maximilian's Viper). This variety showed marked convulsions.

Factors influencing the constancy of toad, *Bufo arenarum* (Hensel), response to K were hormonal. Removal of either adrenals or pituitaries lowered resistance (Houssay). In normal toads (of which we used over 500), the sequence of events after K were: (a) slightly flaccid abdominal muscles (15 mins.); (b) a slow jump reflex; (c) the animal cannot stand up well, but head sinks down; (d) when put on its back, it turns over with difficulty; and (e) cannot turn over but there is a contralateral reflex when one limb is touched.

With sub-lethal doses the recovery from these is rapid.

Later, there is no response to any stimulus and the animal appears dead with the entire body absolutely limp. However, there may be an extremely slow heart beat and there may be a recovery from this state after as much as 5 hours. During this absence of respiration, the oxygenation must occur in the skin capillaries.

Although temperature did not greatly influence the ultimate outcome of K injections, it did alter the symptoms.

At 37° Centigrade (our body temperature), the toads were much more active than at a normal room temperature of 20° to 22°. Their ability to jump higher and more often was especially marked if the animals were put in a warm room for an hour before injection of KCl solution. As the K effect occurs, their actions were slower and muscle tone less. If the toads did jump, they rested longer before the next jump. Recovery, after sub-lethal K, was more rapid in the warm room.

In the cold, 0° to −3° C., the toads are very sluggish in all their movements and the righting action of the animals after being placed on their backs must be watched for a longer period of time. There is a difference in the "feel" (i.e., the muscular tension of abdominal muscles) of animals slow from the cold and slow from potassium. The flabbiness from K predominated over the stiffness from cold as the syndrome progresses.

In the cold, it was also difficult to determine death. Animals, put aside as dead because respiration had ceased and the heart beat could not be palpated, recovered later even though they had apparently been dead.

These clinical observations on lethal and sub-lethal K actions led to some special studies on the toad.

The first, with Dr. Cicardo was an attempt to determine whether the asthemia was due to a failure of nerve conduction or of the myo-neural junction. The condensor method of Lapique, using silver-chloride electrodes, was used to determine the rheobase and chromaxia of nerve and muscle. Central nervous excitability was measured by the voltage necessary to produce a

contralateral reflex, using a condensor discharge with a frequency of 20 stimuli per second. We found a definite diminution of the reflex excitability which coincided with observable asthemia of the animal. The voltage necessary to produce a contralateral reflex increased until no reflex was obtained. Recovery of all animals was observed after 1 ml. of 6% KCl per 100 g. Neuromuscular excitability was not related to the asthemia except in the 17% in which a reversible curarization appeared. Muscle showed an unusual K effect which we are unable to explain. The rheobase, or current potential necessary to produce a contraction, was high and continued to rise 8 to 24 hours after the recovery phase. This lack of response to direct stimulation was particularly notable in that the muscle responded to normal stimulation of its nerve and there was a complete integration of spontaneous movements in the animal. This phenomenon was not due to polarization of the electrodes since it was also determined with alternating current.

These results led to a study of spontaneous central nervous activity with the cathode-ray oscillograph, recording what are commonly called brain waves. With Dr. Odoriz' apparatus and skill, continuous photographic records were made which showed that normal brain activity was at first stimulated, then inhibited, and finally stopped, as the K content of the blood increased after intraperitoneal injection of KCl solution. By placing electrodes in various locations, it was found that inhibition of spontaneous activity by K occurred first in the brain and 10 to 15 minutes later in the cord. Recovery was in the reverse order. Spinal reflexes could be obtained at a time when spontaneous brain activity was stopped. To put it simply, there were times when a toad could not move of his own accord, but would attempt to jump, if poked. It might then become completely non-reactive but an hour later be hopping around at a great rate.

The difficulties encountered in determining when a heart had really stopped beating led to the use of electro-cardiographic recordings of the heart beat before and after K. Dr. Arrighi had developed a technique of holding the electrodes next to the right fore-and left hind-limb of the naturally moistened toad, in such a

manner that the animal was temporarily quiet enough to permit electrical recording of the heart beat. During the period that the persuasive powers of K were acting on the CNS, no restraint was necessary and beautiful records were possible. These showed a slowing of the rate not only of the heart but of the sequence of each part of the heart. A perceptible beat thus became a slow motion event. In animals dying from a lethal K dose, the thorax was opened and the contractions of sinus, atrium, ventricle and aortic bulb could be seen separately. The natural recovery from this state after sub-lethal injections could be speeded up by treatment with NaCl.

These special studies when correlated with the general symptoms observed in all species injected, lead us to reaffirm that the uniformity of response to K is a fundamental biological phenomenon of living cells. The exact location of a maximum effect is dependent on the amount of K given and the region and speed of administration.

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SECTION OF ANTHROPOLOGY

MAY 25, 1942

DOCTOR C. R. CARPENTER, The Pennsylvania State College: *Characteristics of Social Behavior in Non-Human Primates.* (This lecture was illustrated by motion pictures.)

It is the purpose of this lecture to describe some of the important characteristics of non-human primate behavior. I mean by *behavior*, as used in this lecture, observable patterns of movement, in one or more individuals, as the activities occur in complex stimulus fields. The consequences of these actions are also implied. Social behavior refers to the reciprocal interactions of two or more animals and the resulting modifications of an individual's action systems. The term, *characteristic*, will be used somewhat synonymously with the word, *mechanism*, and means a prominent action pattern or action principle which persists in individuals of a species and has adjustive value.

The following assumptions are believed to be basic to later discussion:

(1) The study of the phylogenesis of behavior and social relations on the non-human primate level will facilitate the understanding and control of human activities. This approach is likely to reveal archaic behavior mechanisms which are organically functional on the human level.

(2) The kinship of non-human primates to man makes it reasonable to assume that the study of these types may yield data which can be readily employed in understanding basic kinds of human motivation.

(3) It is obligatory, if some problems of behavior and social relations are to be studied validly, not only to study *animals as wholes* but to study *whole animals in their natural groupings in that environment which has been operating selectively on the species and in that environment to which the species is fittingly adapted.*

(4) All behavior, including that called cultural, has ana-

tomical and physiological counterparts. The cause and effect relationship is reciprocal and not uni-directional. Through learning, for example, modifications may result in the organism, particularly in sub-microscopic structure of the brain, which persistently modify the animal's subsequent behavior and social reactions.

The Characteristics of Interactance.

The principle of interactance holds that primates of a group interact each with the other. Theoretically, each individual in a group consisting of 18 howler monkeys has the possibilities of interacting with every other individual. By applying the formula $N \frac{(N-1)}{2}$ it is found that there possibly would be 156 paired interactions. However, the actual intra-group interactions are not as uniform and simple. Animal A may react with animals B, C, and D but also animal A may interact with animal E who in turn reacts to animals B, C and G. When one begins a detailed analysis of a naturalistic group of monkeys or apes it is found that the group is *organized*, that it has structure and pattern and that limits (boundaries) are set to possibilities of movements and relations of each individual. The individual in the group has a status dependent on age, sex, behavior characteristics, e.g., strength, dominant motivation, previous conditioning and disposition towards other members of the group. The individual has prestige depending on previous status. Though members of naturalistic groups of monkeys and apes do interact by reciprocal stimulation and response, they do not have freedom of movement. Individuals are only autonomous within the structure of the social group but their ranges of behavior are strictly determined.

The description of natural groups of monkeys and apes requires classification of qualitatively different kinds of interactions. There are at least eleven of these for the average primate monkey group:

(1) Male-Male
(2) Female-Female
(3) Male-Female

(4) Male-young (of different sex and age)
(5) Female-young (of varying ages and sex)
(6) Young-young
(7) Relations of non-group living animals to organized groups.
(8) Group-group relations
(9) Relations of an individual to the total group configuration
(10) Inter-species and inter-genera relations, and
(11) Relations of animals to their ecological matrix.

Characteristics of individuals, other than those of age, sex and social status, enter to further complicate the description. When an observer becomes acquainted with a group like No. 1 on Santiago Island, he learns that *no* individual is exactly alike another. There are observable variations in amounts and kinds of general activity, variations in responses to other members of the same group. These individual differences are reflected or expressed and amplified on the level of complex social behavior.

If the observational focus be narrowed and a single *social bond* (relation) between two monkeys be considered, that bond is found to be a complex expression of interactions between the two individuals. The quality of the social interaction will vary depending upon the prepotency of motivation. The two general possibilities of interactance are positive and negative or affinitive and antagonistic. Infants at play, at one time, shift quickly to fighting, at another time. The male which attacked a female a few minutes ago may now permit her to groom him. The female which permitted the infant to nurse now repells its approaches. The results of the interacting of various kinds and degrees of *social drives* and *social incentives* expresses for the time being the general interactions of the two animals. The general reactivity of two (or more) monkeys in a natural situation is usually rather accurately expressed by spatial arrangements; i.e., distance separating individuals or group scatter.

The social interactions are modifiable through learning and/

or conditioning. Strong positive relations may develop between two or more individuals and these animals react in a consistent and characteristic fashion to each other. A very young male animal that is temporarily non-group living, may avoid approaching one group but react more positively to another. It may, through following the latter persistently and at an increasingly closer range, finally be accepted into the group.

An important feature of this non-human learning of social reactions is that of the recognition of individual differences and their appropriate reaction. This is possibly a feature of the social behavior of most organisms, but it is an especially prominent feature of the social behavior of all primates which I have observed. Each monkey in Group I (Santiago *Rhesus* Colony) reacted differently to 160 ("Diablo") than to any of the other group males (4). Only a short time may pass after a "foreign" female has entered the sphere of a well organized group until she would be recognized and usually attacked and driven from the group or killed.

Thus, it is clear that an analysis of the characteristics interactions within a primate group becomes extremely complex and significant in the study of social behavior.

The Characteristic of Grouping Patterns

When an *adequate sampling* of natural groups of any non-human primate species is studied, it is found the groups show a central tendency as well as a range of variability. The average group size for howlers is 17.3 ± 6.8. The average group or family of gibbons has 4 individuals and ranges from 2 to 6 (1). The same group size is characteristic of the siamang. The age of the grouping may relate to its size for, after groups have been long formed and approach the upper limits of size, group splitting or *apoblastosis* occurs, the parent group is reduced in size, and the nucleus of a new group (or groups) is formed (3). (The process is very analogous to cell mitosis).

Studies of grouping patterns show also that usually there are more intra-group males than females. For the howler, this *socionomic sex ratio* is about 1 : 3. While, for the spider monkeys, the

ratio is approximately 1 : 2, (2) and it is estimated that a 1 : 3 ratio holds approximately for *Rhesus* monkeys. In gibbons which have a characteristic family grouping pattern, the ratio of adult males to females is usually 1 : 1 although there are few exceptions.

When the organization of a sample population is studied, including animals which do not, at the time, live in organized heterosexual groups, variations characteristic of species also are found. Howler males live temporarily alone. Excess spider monkey males live in unisexual male groupings, as do the adolescent and non-group living adult *males* of *Macca mulatta*. It is believed that isolates, both male and female, occur in the gibbon (*H. lar*).

If a unitary or approximately unitary secondary sex (at birth) ratio is assumed for those species which show fewer breeding males than breeding females within groups, then processes of social-sexual selection must be operative. Either (1) some individuals are never allowed to reproduce themselves, or (2) males only have access to females for limited periods of their life span. Available data do not permit a clear cut answer to this problem. I have found that, when male groupings of spider monkeys are collected, young adult, prime and old ages may be represented in the same group. The adolescent males, perhaps, from about 4 or 5 to 6 or 7 years of age, live in unisexual male groups, while old senile individuals may usually live alone or sometimes with one or two very young males. Males in their prime, usually but not always, live in the organized heterosexual group. Individual males may live in groups, however, *and yet not have the chance to reproduce*, for, in addition to living in the group, he must have a requisite degree of dominance status or prestige before he can reproduce.

The Characteristic of Dominance

There is no question but that groups of monkeys and apes are organized around several dominance gradients. By dominance gradient, I mean the order of arrangement of several individuals along a line from low to high dominance. The dominance of one species may vary markedly from that of other species. Furthermore, the dominance status of an individual in a group, as gained

by aggression and maintained by aggression, may blend with a prestige factor, i.e., a kind of perseveration of a previous dominance status.

The variability of dominance or aggressiveness from species to species is shown when baboons are compared with howlers, or when langurs are compared with spider monkeys. There would seem to be a genetic basis for this complex kind of behavior which is manifest by the relative degree to which females, food, preferred positions, etc., are exclusively possessed by an individual. In baboon harems a number of females are exclusively possessed by the overlord. Langur males, too, are very autocratic and intolerant of other males. By contrast, howlers tolerate males of the same group. *Rhesus* males of the same group show a sharp dominance gradient but they, like howlers, do not possess receptive females exclusively. Rather, in both kinds, a type of *rotational mateship* occurs during the period of a female's estrus (1 and 4).

In almost all natural groupings which have been carefully studied, the male or males play the most prominent role in controlling the group. There is clearly a masculine dominance, with the possible exception of gibbons, in which is found equivalence of sexual dominance.

This does not preclude the fact that, among the females, as among males, there is also a dominance gradient. As compared with that of the males, this female dominance gradient is of a lower slope; i.e., females have less absolute dominance than males and they seem to differ to a smaller degree. Nevertheless, the female gradient overlaps that of the males. This means that some of the most dominant females are more dominant than some of the least dominant males.

When dominance is studied in immature animals it is found that there, too, an *unstable* gradient exists. Indeed, the status of an individual *Rhesus* monkey begins to be defined during its infancy, after it has begun to engage in social play.

These dominance gradients importantly affect social controls in the groups. The group scatter, or spacing, during feeding, the

order of locomotion and the order of access to estrous females are a few of the behavior modalities in which the order of response is dependent upon dominance and prestige statuses.

That the male dominance gradient is one of the main axes of an organized group, was shown recently by *an experimental field study* (unpublished). The study demanded continuous observation of Group No. 1 of Santiago Colony for 5 days during each week for a month. Systematic records were kept of all behavior classified as having any degree of aggressiveness. The first week was a control period after which the supremely autocratic male (Diablo) was trapped and held captive. During the third week, No. 174, or male No. 2 in the dominance hierarchy, was trapped and held captive and No. 150 or the No. 3 in dominance order was next trapped. Accumulative systematic records showed changes following each removal.

As soon as the Number One dominant male was removed from the group, the *territorial range* of the group was markedly restricted. The group organization became more fluid and there was an increase in *intra-group conflicts* and fights. Finally when Nos. 1, 2 and 3 were removed, males Nos. 4 and 5 shifted dominance positions. No. 159, previously dominant over 173, was now superseded by 173.

When the three captive dominant males were released, a dozen females surrounded "Diablo" (No. 1 dominant), while fewer clustered around Nos. 174 and 150. There was marked excitement of a peaceful sort. At one time, six females were photographed grooming Diablo, while three and two respectively groomed 174 and 150. After a marked disruption lasting three weeks, the group was suddenly restructured when the dominant males were released.

The Characteristic of Territorialism

All types of primates, which have been adequately studied in the field, have been found to show the phenomenon of territorialism. Organized groups have restricted and sometimes quite limited ranges. In some instances these ranges are exclusively

possessed by a single group, while, at other times and places varying degrees of overlappings are found among neighboring groups. It would seem reasonable to conclude that conditioning and learning importantly determine this territorialism and that these processes relate to the spatial locations of incentives which satisfy basic needs of the individual and the group.

A group of gibbons in its territory is less *tolerant* (more resistant) of another group of gibbons than it is of a group of langurs or macaques. *H. agalis* and the siamang have been observed to feed peacefully in the same tree. This would not happen without conflict with two groups of the same species. The conclusion may be drawn, therefore, that competition is most keen between organized groups of the same species. And this is so, even though the different species have similar food preferences.

The relative dominance of groups and territorial ranges interact. The question has often occurred to me as to why one group, for a while, was more dominant or had right of way over another group and hence had wider freedom of movement. The Santiago studies mentioned above have thrown some light on this question. Group dominance does not relate to the size of the group, for Group 1 was only about one-half the size of Group 2 and contained fewer males (7 to 10), but Group 1 always could take precedence over Group 2. The results of field experiments suggest that the determining factor of inter-group dominance is the *relative dominance of the autocratic male in one group in relation to the autocratic male of another group.* In the experiment, Group 1 lost its freedom of movement and range as soon as "Diablo" was caged.

Characteristics of Interdependence

Charles Darwin and many natural historians following him have so emphasized *"the struggle for existence"* and competition that the facts of *interdependence* in animal societies have not been accurately and fully represented. As a result, the formulated theories and principles of social behavior are faulty, since they are built on inadequate factual bases. An illustration of this is the

common expressions which hold that those aspects of human behavior which are untenable, according to a prevailing ethical system, have been derived from an animal level. Extreme egoism, sadism and masochism are frequently thus designated. By contrast, those activities which are ethically accepted, such as altruism, strong emotional affection and cooperation, are attributed to man's higher intellectual processes if not to super-human origins. The naturalistic approach to the study of social behavior leads to the conclusion that *anlagen* or genetic origins of *all kinds* of human behavior, competitive and cooperative, egoistic and altruistic, affinitive and antagonistic, have roots in the pre-human levels of the phylogenetic series.

The survival and reproduction of groups of monkeys of a species depend on the social coordination—one may say cooperation—of all the individuals of the group. The survival is quite as dependent upon the *epiorganism* as on the organism.

Bi-sexual reproduction requires a degree of coordination of two or more individuals. Particularly, on the non-human primate level the young are born without the capacity for independent survival. They are cared for and protected by their mothers in *Rhesus* monkey groups. Otherwise they are killed usually by members of their own parent groups. The play of young monkeys is highly cooperative and it is during that play that many natural reaction tendencies are modified, matured and established as individual habit systems. Defensive actions may involve the close coordination of all group members in a concerted pattern of attack. In these attacks, individuals are killed, but this is incidental to the fact that the group survives and the species is perpetuated.

The Characteristics of Integration Coordination

A given number of monkeys and apes does not make or equal what I have been calling a group. Suppose we try this experiment: Raise in isolation animals of the species, but of the right sex and age to compose a group which meets the requirements of the formula for the average group characteristic of a species. These

individuals will then be released together. What will happen? Some may so fear others that they flee. Some will be antagonistic and fight. Others will form into groups and remain together. In general, the synthetic group experiment will not fall together, as had been hoped or predicted, into a single organization. Why? Even though the social drives are operative and social incentives are present, the monkeys have not been conditioned to each other. They have not been socialized—i.e., they have not learned to make fitting responses to each other as complexes of stimuli. What is lacking is what I have called *integration*.

Social integration is conceived to begin with birth and to involve definable processes of social learning and adjustment. These processes are organic and involve the expressions and satisfactions of physiological drives. From one viewpoint, effective social integration of an individual conditions it in a manner to make it responsive to the communicative acts, motor expressions including gestures, and vocalizations. These communicative acts, involving specific stimuli patterns and fitting responses, constitute the core of group coordination. Let it be remembered that the stimulus aspects of communicative acts cannot be operative except on a background of social integration—i.e., animals which are conditioned to each other.

In order to emphasize the fact of the dependence of even complex social behavior in physiological processes, I shall, in conclusion, describe an instance of nonconformist behavior in a female *Rhesus* monkey (4). In the Santiago Colony, female No. 144 was a member of Group 5 which consisted of 13 animals. The Group had only one male which was very non-aggressive and lacked a strong sexual drive. When the female No. 144 became sexually receptive and had her drive frustrated in her native group, she left Group 5 and joined Group 1 (Group 5 had the lowest, Group 1 the highest inter-group dominance). At first, she moved tangentially to the group and was repeatedly attacked by the group members, males and females. Later, she formed a consort relation with No. 159, the male 4th in the dominance hierarchy, and then with 150, 3rd in the dominance order, and subsequently she

was accepted by 174 and 160 or those males of highest dominance status. Upon termination of her estrus, she was driven out of Group 1 and subsequently returned to Group 5, her native group. It should be noted that the motives which compelled 144 to leave her group and the conditions upon which she was temporarily admitted to the semi-closed Group 1 were dependent upon the physiological conditions which underlie estrus. Thus, this complex non-conformist social behavior can be said to relate closely to the sex hormones, estrone and progesterone, as these affect the whole organism.

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